

**RESPONSE UNDER 37 CFR § 1.116  
EXPEDITED PROCEDURE  
EXAMINING GROUP 1797**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re application of : Attorney Docket No. 2008\_0020  
Yoav LEVY et al. : **Confirmation No. 9679**  
Serial No. 10/587,586 : Group Art Unit 1797  
Filed July 28, 2006 : Examiner Lyle Alexander  
TIME-TEMPERATURE INDICATOR : **Mail Stop: AF**  
BASED ON VALENCE ISOMERIZATIONS

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**AMENDMENT AFTER FINAL REJECTION**

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

In response to the Office Action of August 6, 2010, please amend the above-identified application as follows:

**AMENDMENTS TO THE CLAIMS**

**1. (Currently amended)** A time-temperature indicator for indicating a temperature change over time, comprising:

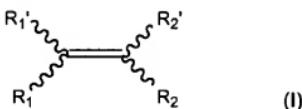
(a) at least one indicator compound selected from the group consisting of a diarylethene compound and a spiroaromatic compound in a first isomeric form, which is converted into a second isomeric form of said indicator compound in a valence isomerization reaction without migration of an atom or chemical group attached to said indicator compound in a time and temperature dependent manner, wherein the formation of the second isomeric form is detectable by monitoring a physical characteristic of the first isomeric form or the second isomeric form of the indicator,

(b) a reference scale for evaluating the degree of decoloration or coloration, and

(c) a protector that prevents renewed photo-induced coloration of the indicator ~~or a cover support designed to avoid photo recharging or photo bleaching~~.

**2. (Canceled)**

**3. (Currently amended)** The time-temperature indicator of ~~claim 2~~ claim 1, wherein the diarylethene is a compound of Formula (I)



wherein:

R<sub>1</sub> and R<sub>2</sub> each independently represent C<sub>6</sub>-C<sub>14</sub> aryl, C<sub>4</sub>-C<sub>12</sub> heteroaryl, conjugated heterocyclic; wherein said heteroaryl and conjugated heterocyclic may contain one to three heteroatoms selected from the group consisting of N, O, and S; and wherein said aryl, heteroaryl, or conjugated heterocyclic may be substituted by one or more halogen, hydroxyl, thiol, amino, C<sub>1</sub>-C<sub>12</sub> alkyl, C<sub>2</sub>-C<sub>12</sub> alkenyl, C<sub>2</sub>-C<sub>12</sub> alkynyl, C<sub>1</sub>-C<sub>6</sub> alkanoyl, C<sub>1</sub>-C<sub>6</sub> alkoxy, C<sub>1</sub>-C<sub>6</sub> alkylthio, C<sub>6</sub>-C<sub>14</sub> aryl, C<sub>4</sub>-C<sub>14</sub> heteroaryl, C<sub>3</sub>-C<sub>8</sub> membered non-aromatic carbocyclic, C<sub>3</sub>-C<sub>8</sub> membered ring non-aromatic heterocyclic, cyano, nitro, sulfo, -CH=CH-CN, azido, or amido;

R<sub>1</sub>' and R<sub>2</sub>' each independently represent H, cyano, nitro, sulfo, hydroxyl, thiol, -CH=CH-CN, or amido; or substituted or unsubstituted C1-C12 alkyl, C2-C12 alkenyl, C2-C12 alkynyl, C1-C6 alkanoyl, C1-C6 alkoxy, C1-C6 alkylthio, C6-C14 aryl, C4-C14 heteroaryl, C3-C8 membered non-aromatic carbocyclic, C3-C8 membered ring non-aromatic heterocyclic; or R<sub>1</sub>' and R<sub>2</sub>' together with the carbon atoms to which they are attached form a C5-C8 carbocyclic ring or a C4-C7 heterocyclic ring containing one to three endocyclic or exocyclic heteroatoms selected from the group consisting of N, O, and S; said N heteroatom may be further substituted by H, or by one or two substituted or unsubstituted groups selected from the group consisting of C1-C12 alkyl, C2-C12 alkenyl, C2-C12 alkynyl, C1-C6 alkanoyl, C1-C6 alkoxy, C1-C6 alkylthio, C6-C14 aryl, C4-C14 heteroaryl, C3-C8 membered non-aromatic carbocyclic, C3-C8 membered ring non-aromatic heterocyclic, hydroxyl, and -CH=CH-CN; when said N heteroatom is tetrasubstituted it is positively charged and is associated with an anion selected from the group consisting of organic and inorganic anions, and optionally wherein said C5-C8 carbocycle is substituted by one or more halogen; and optionally

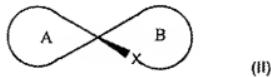
R<sub>1</sub>, R<sub>1</sub>', R<sub>2</sub> and R<sub>2</sub>' each independently represent a charged group or a group substituted by another group having a charge; said charge may be localized or delocalized and may be positive or negative;

and wherein said R<sub>1</sub> and R<sub>2</sub> are in a cis or trans conformation.

**4. (Previously presented)** The time-temperature indicator of claim 3, wherein the diarylethene is

- (a) a symmetric diarylethene selected from the group consisting of 1,2-dicyano-1,2-bis(2,4,5-trimethylthiophene-3-yl)ethane (1); 2,3-bis(2,4,5-trimethylthiophene-3-yl)maleic anhydride (2); 1,2-bis(2-cyano-1,5-dimethyl-4-pyrrolyl)perfluorocyclopentene (3); and 1,2-bis(2,4-dimethyl-5-phenylthiophene-3-yl)perfluorocyclopentene (4); or
- (b) an asymmetric diarylethene selected from the group consisting of 2-(1,2-dimethyl-3-indolyl)-3-(2,4,5-trimethyl-3-thienyl) maleic anhydride (5); and 2-(methoxybenzo[b]thiophene-3-yl)-3-(1,2-dimethyl-3-indolyl) maleic anhydride (6).

**5. (Currently amended)** The time-temperature indicator of ~~claim 2~~ claim 1, wherein the spiroaromatic compound is a compound of Formula (II):



wherein:

ring A represents a C5-C8 carbocycle, C4-C7 heterocycle containing at least one heteroatom selected from the group consisting of N, O, and S; said N heteroatom may be further substituted by one or two groups selected from the group consisting of C1-C12 alkyl, C2-C12 alkenyl, C2-C12 alkynyl, C1-C6 alkanoyl, C1-C6 alkoxy, C1-C6 alkylthio, C6-C14 aryl, C4-C14 heteroaryl, C3-C8 membered non-aromatic carbocyclic, C3-C8 membered ring non-aromatic heterocyclic, hydroxyl, and -CH=CH-CN; when said N heteroatom is tetrasubstituted it is positively charged and is associated with an anion selected from the group consisting of organic and inorganic anions; said C5-C8 carbocycle or C4-C7 heterocycle may be substituted by one or more of the groups selected from the group consisting of halogen, C1-C12 alkyl, C2-C12 alkenyl, C2-C12 alkynyl, C1-C6 alkanoyl, C1-C6 alkoxy, C1-C6 alkylthio, C6-C14 aryl, C4-C14 heteroaryl, C3-C8 membered non-aromatic carbocyclic, C3-C8 membered ring non-aromatic heterocyclic, cyano, nitro, sulfo, hydroxyl, thiol, -CH=CH-CN, azido, amido and amino;

ring B represents a substituted or unsubstituted heterocycle containing at least one heteroatom X, said X being selected from the group consisting of N, O, and S; wherein said N atom may be further substituted by one or two groups selected from the group consisting of C1-C12 alkyl, C2-C12 alkenyl, C2-C12 alkynyl, C1-C6 alkanoyl, C1-C6 alkoxy, C1-C6 alkylthio, C6-C14 aryl, C4-C14 heteroaryl, C3-C8 membered non-aromatic carbocyclic, C3-C8 membered ring non-aromatic heterocyclic, hydroxyl, and CH=CH-CN; when said N heteroatom is tetrasubstituted it is positively charged and is associated with an anion selected from the group consisting of organic and inorganic anions;

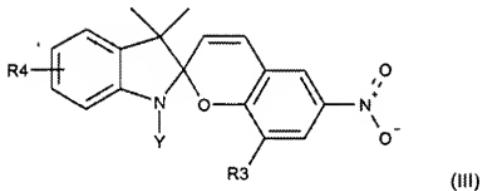
and wherein said ring B may contain one or more endocyclic double bonds and is optionally substituted by one or more halogen;

said rings A and B may be fused to one or more substituted or unsubstituted carbocycle, C4-C14 heterocycle, C6-C14 aryl or C4-C14 heteroaryl ring system;

and wherein the compounds of Formula (II) may be neutral, charged, multiply charged, positively charged having an external anion, negatively charged having an external cation or zwitterionic.

**6. (Previously presented)** The time-temperature indicator of claim 5, wherein the spiroaromatic compound is a spiropyran derivative.

**7. (Previously presented)** The time-temperature indicator of claim 5, wherein the spiropyran derivative is a derivative of 1',3',3'-trimethyl-6-nitro-spiro(2H-1-benzopyran-2,2'-2H-indole) of Formula (III):



wherein:

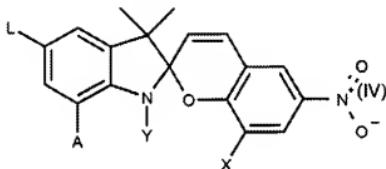
R3 is selected from the group consisting of H, halogen, C1-C12 alkyl, C2-C12 alkenyl, C2-C12 alkynyl, C1-C6 alkanoyl, C1-C6 alkoxy, C1-C6 alkylthio, C6-C14 aryl, C4-C14 heteroaryl, C3-C8 membered non-aromatic carbocyclic, C3-C8 membered ring non-aromatic heterocyclic, and azido; wherein said alkyl, alkenyl, alkynyl, aryl, heteroaryl, and non-aromatic carbocycle may be substituted by one or more group selected from the group consisting of halogen, hydroxyl, thiol, amino, alkoxy, nitro, azido, and sulfo;

R4 is selected from the group consisting of C1-C12 alkyl, C2-C12 alkenyl, C2-C12 alkynyl, C1-C6 alkanoyl, C1-C6 alkoxy, C1-C6 alkylthio, C6-C14 aryl, C4-C14 heteroaryl, C3-C8 membered non-aromatic carbocyclic, C3-C8 membered ring non-aromatic heterocyclic, hydroxyl and -CH=CH-CN; and

Y is selected from the group consisting of C1-C25 alkyl and C7-C15 aralkyl, wherein said alkyl and aralkyl is optionally substituted by one or more halogen.

**8. (Previously presented)** The time-temperature indicator of claim 5, wherein the spiroaromatic compounds include at least one of the following: spirooxazine or its derivatives, spironaphthoxazine or its derivatives, and spiroindolinopyridobenzoxazine or its derivatives.

**9. (Withdrawn-Currently amended)** ~~A- The time-temperature indicator of claim 1, wherein the spiroaromatic compound is a compound of general Formula (IV):~~



~~wherein wherein:~~

A and L are independently of each other selected from the group consisting of H, halogen,

C2-C12 alkenyl, C2-C12 alkynyl and , wherein R is C1-C6 alkyl, C1-C6 alkoxy, C6-C14

aryl and C7-C15 aralkyl; wherein said alkenyl, alkynyl and , may be substituted by one or more ~~group groups~~ selected from the group consisting of halogen, hydroxyl, thiol, amino, alkoxy, nitro, azido, sulfo, aryl and heteroaryl;

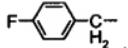
Y is selected from the group consisting of C1-C25 alkyl and C7-C15 aralkyl, wherein said alkyl and aralkyl is optionally substituted by one or more halogen; and

X is C1-C6 alkoxy or L;

with the proviso that Y is not n-propyl when L, A and X are hydrogen.

**10. (Withdrawn-Currently amended)** The spiroaromatic compound-time-temperature indicator of claim 9, wherein

L is hydrogen, Cl, Br or I;



Y is methyl, n-propyl, n-octadecyl or

X is hydrogen or methoxy; and

A is hydrogen;

with the proviso that Y is not n-propyl when L and X are hydrogen.

**11. (Withdrawn-Currently amended)** A printing ink or printing ink concentrate, comprising the spiroaromatic compound-time-temperature indicator of claim 9.

**12. (Withdrawn-Currently amended)** A high molecular weight material, comprising the spiroaromatic compound-time-temperature indicator of claim 9.

**13. (Currently amended)** A method of manufacturing the time-temperature indicator of claim 1, comprising the steps of

(a) embedding in or atop a matrix at least one indicator compound selected from the group consisting of a diarylethene compound and a spiroaromatic compound;

(b) inducing the formation of a metastable state of said embedded indicator compound; and

(c) covering the time-temperature indicator with a cover support designed to avoid photo recharging and/or photo bleaching protector that prevents renewed photo-induced coloration of the indicator.

**14. (Cancelled)**

**15. (Previously presented)** The time-temperature indicator of claim 6, wherein the spiropyran derivative is selected from the group consisting of 1',3',3',8-tetramethyl-5-hydroxymethyl-spiro(2H-pyran-2,3-c]pyridine-2,2'-2H-indole) and 1',3',3',8-tetramethyl-spiro(2H-pyran-2,3-c]pyridine-2,2'-2H-indole).

**16. (Previously presented)** The time-temperature indicator of claim 7, wherein in Formula (III) Y is selected from the group consisting of C1-C25 alkyl and C7-C15 aralkyl, wherein said alkyl and aralkyl are substituted by one or more fluorine.

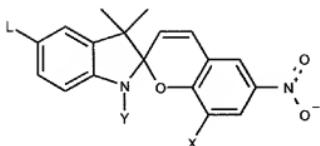
**17. (Withdrawn-Currently amended)** A spiroaromatic compound The time-temperature indicator of claim 9, wherein in Formula (IV) Y is selected from the group consisting of C1-C25 alkyl and C7-C15 aralkyl, wherein said alkyl and aralkyl are substituted by one or more fluorine.

**18. (Withdrawn-Currently amended)** A printing ink or printing ink concentrate, comprising the spiroaromatic compound time-temperature indicator of claim 10.

**19. (Withdrawn-Currently amended)** A high molecular weight material, comprising the spiroaromatic compound time-temperature indicator of claim 10.

**20. (Cancelled)**

**21. (Currently amended)** The time-temperature indicator of claim 2 claim 1, wherein the spiroaromatic compound has the formula



wherein L is hydrogen, Y is and X is methoxy.

**22. (Withdrawn-Currently amended)** A packaging material or a label that comprises a time-temperature indicator for indicating a temperature change over time, ~~said time-temperature indicator comprising~~ comprising:

(a) at least one indicator compound selected from the group consisting of a diarylethene compound and a spiroaromatic compound in a first isomeric form, which is converted into a second isomeric form of said indicator compound in a valence isomerization reaction without migration of an atom or chemical group attached to said indicator compound in a time and temperature dependent manner, wherein the formation of the second isomeric form is detectable by monitoring a physical characteristic of the first isomeric or the second isomeric form of the indicator,

(b) a reference scale for evaluating the degree of decoloration or coloration, and

(c) a protector that prevents renewed photo-induced coloration of the indicator ~~or a cover support designed~~ to avoid photo recharging or photo bleaching.

**23. (Previously presented)** The time-temperature indicator of claim 3, wherein  $R_1'$  and  $R_2'$  together with the carbon atoms to which they are attached form a C5-C8 carbocyclic ring, wherein the C5-C8 carbocyclic ring is substituted by one or more fluorine atoms.

## **REMARKS**

Further and favorable reconsideration is respectfully requested in view of the foregoing amendments and following remarks.

### **I. Claim Amendments**

Claims 1-13, 15-19 and 21-23 were pending in this application when examined. Non-elected claims 9-12, 17-19 and 22 were withdrawn from consideration.

Claim 1 has been amended to incorporate “a diarylethene compound and a spiroaromatic compound” from claim 2, and to delete “or a cover support to avoid photo recharging or photo bleaching”. As a result, claim 2 has been cancelled; claims 3, 5 and 21 have been amended to depend from claim 1; and claim 13 has been amended to correspond with the amendments to claim 1.

In addition, withdrawn claim 9 has been amended to be directed to the time-temperature indicator of claim 1, and to make minor editorial changes. As a result, claims 10-12 and 17-19 have been amended to correspond with the amendments to claim 9.

In addition, withdrawn claim 22 has been amended to include all of the features of the time-temperature of claim 1.

Accordingly, Applicants respectfully request rejoinder of withdrawn claims 9-12, 17-19 and 22, because each of these claims either depends directly or indirectly from claim 1, or includes all of the features of claim 1.

### **II. Claim Rejection Under 35 U.S.C. § 103**

The Examiner rejects claims 1, 2, 5-8, 15, 16, 21 and 23 under 35 U.S.C. § 103(a) as being unpatentable over Ignacio et al. (“Ignacio”) in view of Zweig et al. (US 2003/0139903) (“Zweig”). As applied to the amended claims, Applicants respectfully traverse the rejection.

Ignacio discloses a spiropyrane. Zweig discloses a time-temperature indicator comprising a non-identified and, hence, non-enabled, colorimetric indicator and a reference chart (see paragraph [0031]). The nature of the colorimetric indicator does not appear to be disclosed anywhere, but it is evident from paragraph [0031] that the indicator becomes darker upon exposure to temperature. Applicants note in this connection that initially the inner ring of Zweig “should be a lighter color than the outer ring” (see paragraph [0031]). Furthermore, as

stated in paragraph [0031], if the inner ring changes color and matches, or is **darker** than the color of the outer ring, then the test elements have been exposed to excessive temperatures for a prolonged period of time.

**Neither Ignacio nor Zweig disclose or suggest “a protector that prevents renewed photo-induced coloration of the indicator”, as recited in claim 1.** In an effort to remedy this deficiency, the Examiner states the following in item 5 on page 5, “it is notoriously well known in the art to place a cover over an indicator to protect the indicator from photo-degradation and prolong the shelf-life of the indicator.” Moreover, in item 6, the Examiner asserts that “it would have been within the skill of the art to place a cover over the compound of Ignacio et al. to gain the expected and well known results of prolonged shelf life.”

These statements by the Examiner appear to be based upon a misunderstanding of the presently claimed invention. **In the presently claimed invention, the function of the protector is not to prolong the shelf-life of the indicator.** Moreover, the presently claimed invention **does not darken the indicator as a time-temperature depending step, but for the opposite purpose, i.e. for decoloration**, as explained in the paragraph bridging pages 4 and 5 of the specification. It has been found that **the darkening step of spiroyrans and diarylethenes cannot be meaningfully used to indicate time and temperature.** According to the presently claimed invention, a spiroaromatic compound or a diarylethene compound is transferred into a colored state by irradiation with UV-light. As a result, a protector is applied **to avoid renewed coloration** by the UV portion of sunlight so that the **decoloration of the indicator** can proceed **solely as a function of time and temperature.** Furthermore, **the protector according to the presently claimed invention is not a simple intransparent “cover”,** because such an **intransparent cover does not allow one to monitor the color change**, but requires a sophisticated color filter to hinder certain wavelengths to reach the diarylethene or spiroaromatic indicator compound.

Accordingly, the combination of Ignacio and Zweig would not have led to the time-temperature indicator for indicating a temperature change over time, comprising “a protector that prevents renewed photo-induced coloration of the indicator”, as recited in claim 1.

Ignacio merely discloses a spiroaromatic compound. **Zweig does not appear to disclose or suggest a protector** that prevents renewed photo-induced coloration of the indicator; does not teach or suggest using the **decoloration** process; and uses unidentified and, hence, **non-enabled** indicator compounds that use the **coloration** process to indicate time and temperature.

On the other hand, the presently claimed invention uses a **decoloration** process which **absolutely requires a protector** in order to prevent renewed photo-induced coloration of the indicator.

Accordingly, one of ordinary skill in the art would not have arrived at the presently claimed invention from the disclosures of Ignacio and Zweig.

Therefore, claim 1 would not have been obvious over the references.

Claims 3-8, 13, 15, 16 and 21 depend directly or indirectly from claim 1, and thus also would not have been obvious over the references.

Accordingly, reconsideration and withdrawal of the rejection are respectfully requested.

### **III. Claim Objections**

The Examiner objects to claims 3 and 4 as being dependent upon a rejected base claim, but indicates that they would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Applicants appreciate the indication of allowable subject matter, but respectfully submit that claim 1, from which claims 3 and 4 depend, is allowable for the reasons discussed above. Accordingly, reconsideration and withdrawal of the objection are respectfully requested.

**IV. Conclusion**

For these reasons, Applicants take the position that the presently claimed invention is clearly patentable over the applied references.

Therefore, in view of the foregoing amendments and remarks, it is submitted that the objection and rejection set forth by the Examiner have been overcome, and that the application is in condition for allowance. Such allowance is solicited.

Respectfully submitted,

Yoav LEVY et al.

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By Freistein/

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